# PROPOSAL FOR

## TECHNICAL ADVISORY SERVICES RELATING TO GEOTHERMAL RESOURCE ASSESSMENT

FOR THE

## DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT AND TOURISM
## ENERGY DIVISION


R. A. PATTERSON & ASSOCIATES

W. L. D'Olier
K. P. Goyal
H. P. Ross
R. A. Patterson


APRIL 1991

3. Mr. D'Olier and Mr.Patterson have detailed knowledge of the specifics and progress of the geothermal/cable project; each participated as consultants to parties active in the Hawaiian Electric Company-State RFP and Proposal process that developed during the period May 1989 - January 1990.

   Mr. D'Olier was a consultant to Stone & Webster Engineering Co. (SWEC), which in turn was the prime technical advisor to Hawaiian Electric Co.(HECO).

   Mr. Patterson consulted for Mission Power Engineering Co., materially assisting in the management and writing of the proposal which was chosen by HECO as the most responsive to their requirements.

II. SUMMARY - STATE AND DBED OBJECTIVES

**R. A. Patterson & Associates** will work with an accurate and thorough understanding of the objectives of DBED energy division and the state administration. These objectives are succinctly presented in the RFP. Our understanding of the purpose and direction of the consulting work is presented below.

STATE AND DBED OBJECTIVES

1. Determine the extent and magnitude of the geothermal resources within the State. Active deep drilling, well testing and commercial production later this year should allow a regional determination to be made first in the KERZ.

2. Identify the characteristics of the geothermal resource.

3. Determine the potential of the resource for commercial exploitation, and long term conservation and management.

4. Optimize DBED's management and supervision of the geothermal resource assessment program and geothermal/cable project master planning with the assistance of a qualified geothermal industry consulting group, selected by a competitive bidding process.

5. Improve the resolution of geothermal development issues and problems between agencies, and between agencies and the commercial developers, using the consulting team. Key agencies. DBED, Department of Land and Natural Resources (DLNR), Department of Health (DOH), Hawaii County, the Technical Advisory Committee (TAC), University of Hawaii (UH), and the US Geological Survey (USGS) will be key agencies in this process. The contractor will participate as DBED's advisor in key meetings, by making analyses and recommendations, and by the submission of written reports.

6. Publish two comprehensive status reports (SR) on the geothermal energy resource. The Contractor will prepare a

draft of the first status report by December 1991 for presentation to the 1992 state legislature. The draft of a second report will be due in May 1992 for presentation as an annual report to the state administration and the public.

A wide array of current activities and past achievements in the KERZ support the objectives stated above.

The HGP-A generating facility completed nearly 8 years of high capacity electrical generation (March 1982-December 1989). The single geothermal well - HGP-A, which supplied the 2.4 MW plant, is capable of continued production of 350° F fluids.

One private industrial group, the Puna Geothermal Venture, is completing a well field to commence electric generation later in 1991 from a new 25 MW plant. This power, to be sold under contract to Hawaii Electric Light Company (HELCO), will serve the Big Island grid. PGV has plans for a second 30 MW plant, to be built somewhere in the KERZ area. A second private group, True/Mid-Pacific Geothermal Venture, has by deep drilling demonstrated electric grade resource potential at a locale 7.5 miles uprift from the HGP-A well. This exploration activity is continuing, and True/Mid-Pacific has signed an "as available" contract with HELCO for 25 MW of power for the Big Island.

Italian (ENEL) and New Zealand (R. James) geothermal experts examined the KERZ in 1990. ENEL allowed that "deep drilling has confirmed the presence of an industrially exploitable system." Russell James estimated the KERZ power potential in the range of 500 to 700 MWe, based on the work done to date, and the limited information thus obtained.

Studies by the UH and others, have evaluated the geothermal potential for other parts of the Big Island and other islands in the Hawaiian chain.

Unfortunately, the KERZ achievements are not all positive. Serious implications about well field productivity and costs are being raised by the drilling to date.

- Of 9 deep geothermal wells, three (True 1, Ashida 1 and Lanipuna 1) found favorable high temperatures but little or no fluids. This 30+% incidence of failure points to the critical problem of finding the fracture permeability for adequate fluid production.
- Steam flow rates in five productive wells (HGP-A, Kapoho State-1 and -1a, -2 and -3) are very modest in range and volumes; 72,000 to 33,000 pounds per hour. This low yield per well could place severe economic constraints on development.
- Steam finding costs per well are high; Kapoho State-1 and 3, with respective 72,000 and 70,0000 lbs/hr flow rates and $2.5 and $3 million completed well costs show funding costs of $33 and $43 per pound-hour of steam. *Although the comparison is not wholly appropriate, equivalent costs in the Geysers were $7-$15 per pound-hour of steam in the mid 1980s.*

All of these findings reveal the pressing challenges in the KERZ; locate the permeable reservoir and improve well productivity. The DBED and State objectives are well founded and timely. We believe that determination of the extent and magnitude of the geothermal resource is the paramount challenge. Deep drilling, flow test, and production data, extended by competent reservoir engineering, geologic and geophysical surveys, analyses and interpretation, will be the basis of this determination. All other sectors of interest will be impacted by these findings.

The core team assembled by **R.A. Patterson & Associates** has unique credentials in KERZ drilling, flow testing, and geotechnical operations, and in evaluation and surveys for this challenge in geothermal resource assessment in Hawaii.

## III. CONTRACT SCOPE OF WORK

The Contract Scope of Work as written in the RFP, is incorporated in this Proposal for clarity and comment. The work elements have been enumerated as Tasks 1 through 7 to better identify these separate sectors of the total work under the proposed Contract. In addition, such identification will serve to facilitate work progress reports, and to categorize professional fees and other charges on monthly invoices.

Each Task will be accomplished jointly and personally by several or all members of the team of four professionals cited in Sections I and V of this Proposal. Work on all Tasks will commence immediately, assuming the final execution of the Contract Agreement with DBED, on or about 1 July 1991. Anticipated work efforts and products, discussed in section IV, support the seven Tasks which constitute the Contract Scope of Work.

The tasks are here reproduced from the RFP, along with comments on our anticipated approaches to the work specified. Team assignments will be made to adequately cover the work required as each item is begun, after direction from the DBED staff.

### TASK 1

**• RPA, as Contractor, will assist DBED and DLNR in establishing priorities among available resource assessment methods, including (as examples): exploratory drilling; core-sampling and well-testing; surface and aerial surveys; and regional mapping. Guidance in this regard must be sensitive to budget constraints.**

This task will receive integrated technical attention from D'Olier, Goyal and Ross. Patterson will identify all budget considerations to assist priority determinations and identify alternate responses to unexpected events or issues.

TASK 2

**• RPA, as Contractor, will assist DBED and DLNR in planning the direction of and managing the SOH program and in evaluating available exploratory drilling methods, with cost effectiveness being a major criterion.**

The entire RPA team brings special qualifications to Task 2, having recently completed the SOH Program Review, and other technical and management evaluations, under contract to DBED Energy Division. Our record of responsiveness and accomplishment points to our abilities to work as a productive team in this area. Patterson and Goyal will devote special efforts to permitting and flow testing in the second round of SOH operations. D'Olier will lead team considerations of SOH cost effectiveness.

TASK 3

**• Contractor will assist DBED and DLNR in designing and planning appropriate well tests, surface and aerial surveys, and/or sampling projects. Provide advice on appropriate instrumentation and equipment, methods and procedures, personnel, and budgets.**

Task 3 will require detailed and coordinated analysis by D'Olier, Goyal and Ross. Two related action paths will be used;

1) cooperative testing with full-sized geothermal wells and SOH's to better identify productive geothermal reservoir; and
2) carefully selected geophysical procedures and surveys to predict reservoir extensions from the well data base.

TASK 4

**• Contractor will assist DBED and DLNR by providing technical guidance relative to the geothermal/cable project master plan and EIS being prepared by the consulting firm, ERCE.**

Mr. Patterson, residing in Honolulu, will direct Task 4 considerations for the geothermal/cable master plan and EIS. He has ready access to the ERCE staff, and a previous small consulting assignment with the ERCE office in Honolulu.

TASK 5

**• Contractor will assist DBED and DLNR by providing technical guidance relative to planning and design of the geothermal/cable project by the consortium and HECO.**

RPA offers particular qualifications to accomplish Task 5. D'Olier, working jointly with Stone & Webster Engineering Corporation for HECO, helped to write the May 1989 RFP for the geothermal/cable project and completed the technical evaluations of all five Proposals submitted (Nov. 89-Jan. 90).

Patterson, while consulting for Mission Power Engineering Company, directed the preparation of the winning proposal selected by HECO.

**TASK 6**

**• Contractor will assist DBED and DLNR to make reasonable judgements and to reach objective scientifically supported, conclusions about the extent and characteristics of geothermal resources, recognizing that such judgments and conclusions may serve as the basis for public policy and/or investment decisions.**

Task 6 is an exceptional scientific and technical challenge; it is taken as full notice that DBED and DLNR want a credible new evaluation of the geothermal resource. We believe that RPA's new team of geologist, reservoir engineer and geophysicist bring the quintessential disciplines to this critical Task.

**TASK 7**

**• Contractor will advise DBED and DLNR on well-field design and management in order to assist them in adopting appropriate policies, standards, and design criteria to avoid over-production and premature depletion of geothermal resources.**

Goyal and D'Olier will lead the considerations in Task 7. Well fields designed for production, injection and monitoring functions must respect land use status, seismic, and volcanic risks in moving geothermal energy from reservoir to generating plant. Reservoir and resource management will be critical in Hawaii geothermal utilization; prudence in development and a keen perception of reservoir and resource vulnerabilities will be essential to effective long-term conservation and management of a critical energy resource for the entire State. We expect that the newly-organized Technical Advisory Committee will play a pivotal role in this work, and we are planning a close association with this group.

## IV. DELIVERABLES AND LEVEL OF EFFORT

<u>Anticipated Work Efforts and Products</u> - The team is fully prepared to provide the following deliverable reports, memos, and other inputs to the overall efforts detailed above.

*** attendance upon request at key meetings of State interagency technical and policy committees involving DBED, DLNR, other State agency officials, and, on appropriate occasions, representatives of involved institutions such as the University of Hawaii and USGS.**

*** preparation, as needed of written reports addressing specific aspects of or problems concerning resource assessment work in progress and making specific recommendations.**

* submission, on or before December 1, 1991 (approximately one month prior to the start of the 1992 legislative session), of an interim draft written reports on geothermal resource assessment, consisting of the following information: (1) a status report on the State's geothermal resource assessment program; (2) a description and brief analysis of available data and information from all public and accessible private sources; and (3) a summary of reasonable judgments and objective conclusions which the consultant is able to make from the available data and information about the extent and nature of geothermal resources.

* submission, at least 45 days prior to the end of the one year contract term, of a draft annual report on geothermal resource assessment including the following kinds of information: (1) a status report on the State's geothermal resource assessment program; (2) a comprehensive analysis of available data and information from all public and accessible private sources; and (3) a summary of reasonable judgments and objective conclusions which the consultant is able to make from the available data and information abut the extent and nature of geothermal resources; (4) a discussion of the accomplishments of the consultant in assisting the program during the contract term; and (5) recommendations with regard to future needs, priorities, and plants. DBED will work cooperatively with the consultant during the early part of the contract term to develop an outline for this report in order to make it as meaningful as possible. The report should address each of the elements covered by the foregoing scope of work.

* submission, at least 5 days prior to the end of the one-year contract term, of a final resource assessment report, incorporating any changes suggested or required by DBED.

## V. RELEVANT WORK EXPERIENCE

### A. TEAM EXPERIENCE

The core team of professionals assembled to perform the work, identified in the RFP and this Proposal, contains the most essential disciplines for the primary task of geothermal resource assessment. D'Olier, Goyal and Ross have long, creditable records in the resource sector of the geothermal industry. Patterson has detailed experience in administering and managing geothermal enterprise and operations in Hawaii, and in general management of highly complex, technically oriented organizations.

Expertise and/or specific skills not available in the proposer's team described can be obtained, if necessary, through other consultants in the geothermal and alternate energy industries in Hawaii and in the western United States. If this is required, we are prepared to make recommendations for additional team members to DBED, based on our knowledge and respect for the qualifications of these new members.

Detailed Statements of Experience and Qualifications for these four team members are presented together in **Appendix A.** The following summary remarks describe specific work experience for each member, relevant to the Scope of Work herein.

William L. D'Olier. Mr. D'Olier is a Registered Geologist, State of California; he is an independent consultant, working exclusively in the geothermal industry since a January 1988 retirement from Thermal Power Company. D'Olier managed for Thermal the drilling and evaluation of 3 KERZ geothermal wells - Kapoho State 1, 2 and 1-A, each of which penetrated the geothermal reservoir and measured steam production during flow tests. In 1983, he directed Thermal staff and Consultant Howard P. Ross in the prosecution and interpretation of an aeromagnetic survey in the lower KERZ. In 1987, with Goyal and Iovenitti, he presented the findings and conclusions of deep drilling and testing in the Puna Reservoir Report which established the basis for the 25 MW geothermal power system now under construction by the Puna Geothermal Venture (PGV).

Mr. D'Olier associated with Stone & Webster Engineering Corporation (SWEC) in the December 1988-January 1990 interval to prepare the RFP for the HECO/State Geothermal Interisland Transmission Project (500 MW and cable) He wrote Appendix A of the RFP, entitled "Geothermal Resources of the Kilauea East Rift Zone" and participated in the technical evaluation of all five proposals received. In recent association with RPA, D'Olier was a key contributor to the SOH Program Review which was completed in January 1991 as technical advisory service to DBED Energy Division. As to regionally oriented geothermal resource assessment, D'Olier has personally accomplished reconnaissance or field and prospect summaries for the following productive or prospective regions:

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| Geysers-Clear Lake KGRA, CA | Island of Java, Indonesia |
| Basin & Range, CA, NV, VT | Luzon and Leyte, The Philippines |
| Cascades CA, OR, WA | Andes Mountains, Chile |

Keshav P. Goyal. - Dr. Goyal is geothermal reservoir engineering consultant, with over 16 years experience in the geothermal industry and research. He is a Professional Engineer, registered in the State of California (Mechanical Engineer specialized in thermal fluid phenomena). He conducted reservoir engineering research at Lawrence Berkeley Laboratory, and has diverse geothermal industry experience. Dr. Goyal was Thermal Power's reservoir and well testing engineer during the Kapoho-State exploration drilling. He designed the equipment and all procedures for KS-1A well flow testing, including well preparation and opening, measurements at multiple rate flows, safety, and abatement procedures. This 1985 activity was a major advance in testing KERZ geothermal wells safely and in obtaining quality data. Dr. Goyal wrote a detailed KS-1A flow test report which contains substantial reservoir information and analysis. He also wrote the Puna Reservoir Report with D'Olier and Iovenitti which is basis for the PGV plans for a 25 MW (net) electric power facility.

Dr. Goyal, in recent association with RPA, made important contributions, particularly in flow testing concepts, to the SOH Program Review. His regional geothermal reservoir assessments have focused on the Basin & Range Province and the Imperial Valley in California and Mexico.

Ralph A. Patterson. - Mr. Patterson was the Hawaii Project Manager for Thermal Power Company for four and one-half years, ending in late 1988 when the Puna Geothermal Venture interests were sold by Thermal Power Company. Mr. Patterson's management responsibilities with Thermal Power included operations, drilling, legal, financial, public and governmental relations, environmental studies and presentations, permitting, and marketing. Mr. Patterson is currently a new business development consultant based in Hawaii.

Howard P. Ross. - Dr. Ross is a Senior Geophysicist and the Section Head for Applied Geophysics with the Earth Science Laboratory Division of the University of Utah Research Institute (UURI). He received his B. A. in Geology from the University of New Hampshire and M. S. and Ph. D. degrees from the Pennsylvania State University. He was a senior geophysicist with Kennecott Exploration Inc. from 1967-1977, where he conducted research in the magnetic and electrical methods, and completed induced polarization/electrical resistivity, aeromagnetic, and gravity surveys for porphyry copper and massive sulfide deposits.

Since joining UURI in 1977, Dr. Ross has served as the Project Manager for the Department of Energy (DOE) Geothermal Division-Industry Coupled Program and for numerous geophysical studies for the mining and geothermal industries and for government agencies. He has been Project Manager for the DOE Geothermal Division-State Cooperative Reservoir Analysis Program since 1985. Dr. Ross has completed geophysical interpretations for numerous geothermal areas in the western United States, and for geothermal resources on Ascension Island (South Atlantic Ocean), Hawaii, St. Lucia, Mexico (Los Azufres), Guatemala (Zunil), Kenya, and Ethiopia. Dr. Ross has been active as a Peer Reviewer for the DOE Nuclear Waste Isolation Program, and as a consultant to U. S. mining and geothermal companies. He is the author of more than 20 journal publications and numerous reports in the fields of geothermal energy, geophysics, remote sensing, and environmental studies.

As a consultant to Thermal Power Company and the Puna Geothermal Venture, Dr. Ross completed a review and interpretation of available geophysical data relating to the Kilauea East Rift Zone (KERZ) in 1983. He subsequently designed, reviewed and interpreted several proprietary detailed geophysical surveys which were completed as part of other geothermal exploration programs, helping to plan, execute and make complete interpretation of Thermal Power Company's KERZ aeromagnetic map in 1985.

B. CONFLICTS/POTENTIAL CONFLICTS

Since all of the team members have been associated with various entities interested in the geothermal developments in Hawaii at some time or other, the following requested statements on conflicts or potential conflicts are included in our proposal. It is our considered opinion that none of these associations will cause any conflicts with the work on resource assessment described by DBED in their RFP. In fact, we believe the close associations that the team has developed with a broad spectrum of the geothermal community in Hawaii will serve to be one of the strongest assets available to DBED.

Disclosure-D'Olier

Mr. D'Olier has no association or affiliation of any kind with firms or parties involved in geothermal exploration or development in Hawaii, with the single exception of an active consulting service to HECO concerning the overall results and implications of the ongoing SOH Program. His former consulting association with SWEC for HECO is no longer active.

Disclosure-Goyal

Dr. Goyal has no current affiliation with any firms involved in geothermal enterprise or study in Hawaii. He is employed as a senior Reservoir Engineer by Calpine Corporation, and has permission to consult in areas not in conflict with his employer's activity.

Disclosure-Patterson

Mr. Patterson was the Hawaii Project Manager for Thermal Power Company for four and one-half years, ending in late 1988. He provided management consulting services to Mission Power Engineering Company, providing general consulting and lobbying services in support of Mission Power's interest in the HECO RFP for geothermal/cable development. He directed the preparation of the winning proposal selected by HECO during this consulting assignment, which ended in mid-1990.

Discussions have been held for several months with Mission Energy Company, successor to Mission Power Engineering Company in the Kilauea Energy Partnership, for a new consulting arrangement to continue services similar to those provided for Mission Power Engineering. Such a new assignment (if enacted) would not appear to cause a conflict with the more technically oriented services to be provided under this proposal. Mr. Patterson has represented Mission Energy as an observer, on a paid daily basis, at two recent meetings regarding geothermal development in Hawaii. There is, however, no contract for further services in place at this time.

Disclosure-Ross

Dr. Ross provided geophysical services as an independent consultant to Thermal Power Company from 1982 to 1983, and to Diamond Shamrock Corporation in 1985, in connection with the Puna Geothermal Venture. Since this work was terminated in 1985, and since the ownership of the Puna Geothermal Venture has changed, no conflict of interest is identified as a result of this work.

Since 1986, Dr. Ross has served as the Technical Project Manager for the DOE-Geothermal Division's State Cooperative Reservoir Analysis Program, while employed at UURI. In this position, Dr. Ross serves as a technical contract monitor, and provides ongoing administrative and contract assistance to the DOE and to 12 state geothermal teams. He also coordinates geophysical, geochemical,geologic and age-dating technical assistance for these state teams. One of these grants is with the State of Hawaii DBED. The technical work for a project "Silica Control and Recovery in Geothermal Fluids" is being conducted at the University of Hawaii at Manoa under the direction of Dr. Donald Thomas. The grant is scheduled for completion on June 20, 1991.

Dr. Phillip M. Wright, Technical Vice President at UURI, and Dr. Marshall Reed, DOE/GD, have Dr. Ross's request to provide consulting services on this project and have indicated that no conflict of interest is present.

## VI. ACCESSIBILITY AND RESPONSIVENESS

The proposal team presented here has a number of specific advantages to DBED. Based in Honolulu, the team will be immediately responsive to the needs of the Energy Division through Mr. Patterson; consultation and involvement in specific problems or discussions will be facilitated by regular telephone, facsimile and written correspondence. Because of its track record in the supplying of similar services to DBED over the past eight months, RPA can be counted upon to effectively concentrate on the core of problems and issues related to geothermal assessment. Direct access by DBED to all team members will be made possible; where needed, coordination of work and deliverables through Mr. Patterson has proven to be successful, and will be continued under the proposed contract.

Team members residing on the Mainland are never far away by rapid communications. In addition, with a minimum of planning and coordination through Mr. Patterson, attendance by other team members at specific meetings, with minimum fuss, is possible. Since travel costs are not directly productive to the work at hand, minimizing such costs should be a prime goal of contractor selection and contract administration. The record of RPA, under its previous DBED contracts, in managing such necessary travel to Hawaii at the least cost, and indeed in meeting with DBED staff during seminars on the Mainland, is an illustration of the cost consciousness that RPA brings to the work presented.

## VII. CONTRACT COSTS

Hourly rates for each of the team members are proposed at $80. An overhead fee of 20% of the hourly rate will be added to all professional hours to cover regular communications, secretarial services and administrative costs.

Major costs, such as for publications, maps and complex graphics, etc, plus travel expenses will be billed at cost. Hawaii GET will be added to billings as appropriate.

Invoicing will be on a monthly basis in accordance with DBED requirements.

# TECHNICAL ADVISORY SERVICES PROPOSAL

# APPENDIX A

# RESUMES

R. A. PATTERSON & ASSOCIATES
APRIL 1991